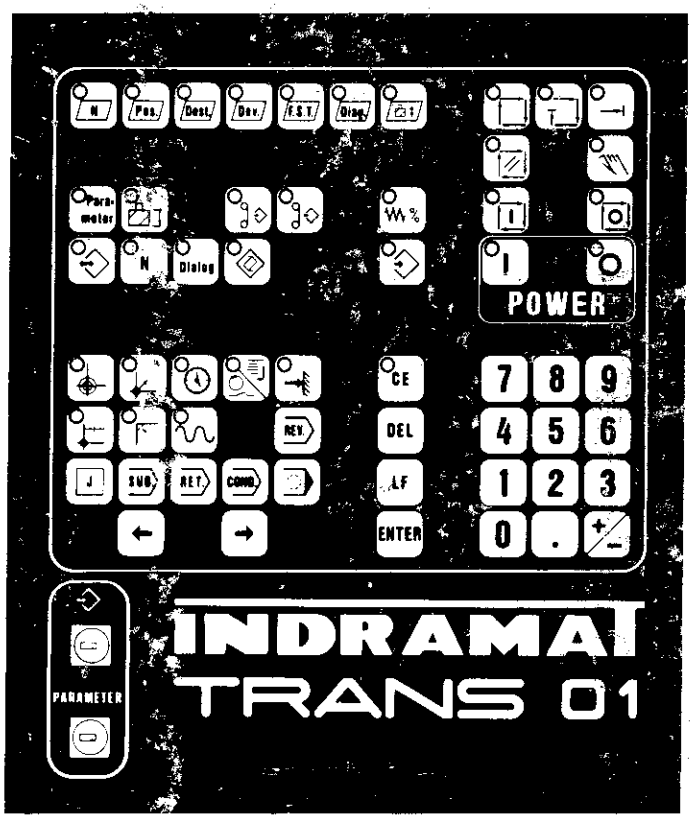
TRANS-01
TRANSFER LINE CONTROL
USER'S MANUAL



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Precision Control For Automation

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RECORD OF REVISIONS

Revision Level	Date	Description of Change
	12/81	Preliminary Version
A	05/82	Original Release
B	02/83	Updated to reflect TR04 & TR05 software changes
C	06/86	Updated to reflect version TR1X-003.X and TR2X-003.X software changes; optional rotary motion control description and optional feed adaption descriptions added in Chapter 9.
D	02/90	Updated version.

NOTE: A TRANS-01 control with earlier revision level software than TR1X-003.X or TR2X-003.X may not include all functions described in this manual and differences may be noted in certain other functions.

FOREWORD

SPECIAL NOTATIONS:

Special notations are used throughout this manual to assist the reader in identifying unique conditions or important information. There are three categories of notation:

NOTE: Used for important information concerning operation, exceptions, or other detailed information not covered previously.

CAUTION: Used when conditions exist which could cause damage to the equipment.

WARNING: Used when conditions exist which could result in personal injury.

Please note that due to the variations in applications, operating conditions and work environment, the special notations in this manual cannot identify all potential problems or hazards. Caution and discretion must always be used in operating machinery, and with the use of electrical power. Equipment should only be installed and operated by trained personnel. Installation and training services are available from Rexroth Indramat.

TRANS-01 TRANSFER LINE CONTROL USER'S MANUAL

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

CHAPTER 6. FUNCTIONAL DESCRIPTIONS

TABLE OF CONTENTS

CHAPTER 7. MOUNTING AND INSTALLATION

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TRANS-01 TRANSFER LINE CONTROL USER'S MANUAL

TABLE OF CONTENTS

List of Figures

TRANS-01 TRANSFER LINE CONTROL USER'S MANUAL

TABLE OF CONTENTS

TRANS-01 TRANSFER LINE CONTROL USER'S MANUAL

TABLE OF CONTENTS

CHAPTER 1. GENERAL DESCRIPTION

1.1 INTRODUCTION

1.1.1 General

The TRANS-01 is a microprocessor-based programmable control designed for control of transfer lines and flexible machining systems. The basic function of the TRANS-01 control is the numerical control of an INDRAMAT AC servo drive as a feed drive operating a slide, as well as the control of program dependent switching functions. It is supplied in a rigid, compact, sealed enclosure, designed for wet machining environments, and can be mounted directly on the machine for true distributed control.

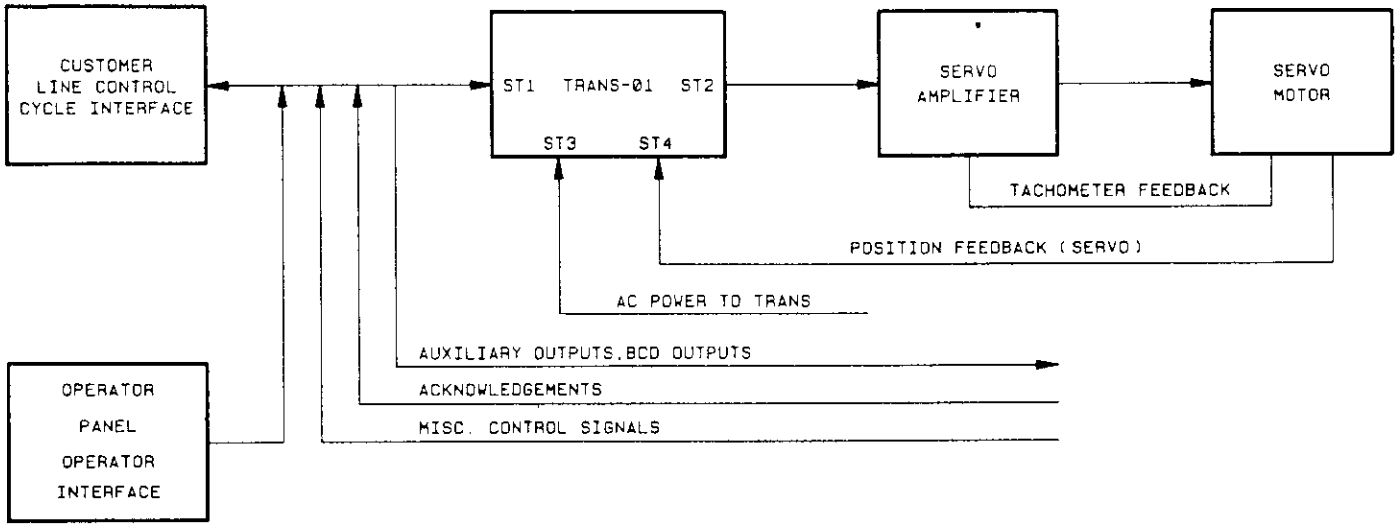
The TRANS-01 is intended for remote operation, where it is controlled by the customer's Line Control, usually a computer or a programmable controller which controls the entire transfer line. The function of the Line Control is to convey commands to and receive information from each TRANS-01 in the system. It can do this using discrete wires to each TRANS -- the parallel Cycle Interface -- or it can use Indramat's optional Line Control Adaptor (LCA) and communicate using one RS-232 serial channel throughout the system. The Cycle Interface provides control lines for one TRANS-01 while the Line Control Adaptor (LCA) can communicate with up to 30 TRANS controls, receiving status and position data, transmitting commands and transferring programs and parameters.

The Line Control can control the TRANS via the LCA, or the LCA can be used to monitor position and status information for display, with the actual control handled over the Cycle Interface. This is determined by setting up TRANS parameters.

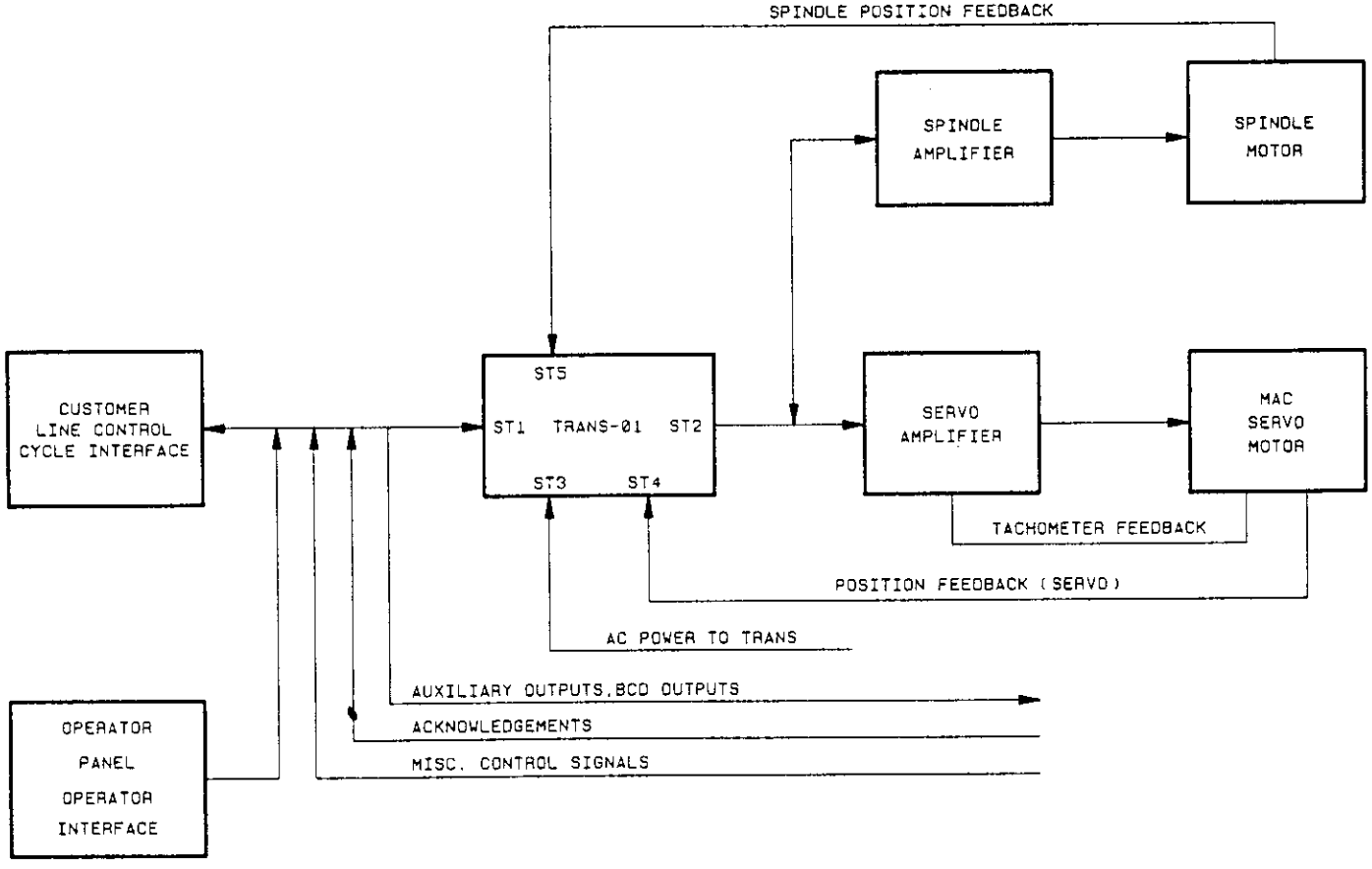
The TRANS-01 can be operated both on-line, controlled by the Line Control, and off-line, controlled from an Operator Station mounted on the transfer unit and/or by the keyboard/display panel of the TRANS-01 itself.

A typical system consists of an Indramat TRANS-01 Control, a model MAC AC Servo motor with integral incremental encoder for position feedback, and a Servo Controller (amplifier) such as a DSC Compact Controller. Complete interconnect cable sets are also available from Indramat. Components are chosen to best fit the required application, and are matched through plug-in personality modules to provide optimum performance without further field adjustments.

Figure 1-1 is a block diagram illustrating typical system configurations.



TRANS-01 SINGLE AXIS INTERCONNECT



SPINDLE BLOCK DIAGRAM (WITH SPINDLE POSITIONING)

Figure 1-1. TRANS-01 System Block Diagram

Both positioning accuracy and system speed are optimized by utilizing closed loop digital positioning. The axis can be positioned either incrementally or absolutely.

The TRANS-01 control includes a memory which can store up to 128 program blocks. Each block contains up to 7 instructions which control some aspect of axis positioning. They are: Homing or Position Command, Feedrate or Dwell Time, Auxiliary Functions, BCD Output, Tool Correction, Block Repeats and Program Jumps. In addition, special commands or software can be used to enable a second spindle axis, adaptive feed, adaptive depth or rotary programming (see Chapter 9 for details).

1.1.2 Programming

The TRANS-01 control can be programmed using two methods:

1. Its operator keyboard/display panel.
2. Via Indramat's optional Line Control Adaptor (LCA), a microprocessor-based serial bus driver (RS-422).

1.1.2.1 Line Control Adaptor

Indramat's Line Control Adaptor (LCA) is designed to communicate simultaneously over an RS-422 serial link with up to 30 TRANS-01 controls on a high production line.

The LCA receives data, such as slide position, diagnostics, I/O status, etc. from each connected TRANS-01 and buffers the information in its RAM memory. An RS-232C port on the front of the LCA connects to a user-supplied device used to manipulate the data. This device can range from a dumb terminal to a large computer. Once connected to the LCA this device (called the Line Control) can request and obtain status information from any or all TRANS-01 controls on the line. It can upload complete part programs, parameters and tool corrections. Additionally, the Line Control can transmit programs, parameters and tool corrections to any TRANS-01 on the bus, and transmit commands such as Start, Enable and Homing.

Complete information on the Line Control Adaptor, including instructions on how to transmit programs, parameters and commands to the TRANS-01 over the RS422 serial channel can be found in Indramat Publication IA 74706.

1.1.2.2 Programming with EPROMS

An EPROM is prepared by first manually entering the user program into the TRANS-01 control, then 'burning' this program into the EPROM using the optional EPROM programmer on the LCA. The EPROM can then be inserted into a socket on the back of the TRANS-01 to provide a permanent program; can be used with the EPROM programmer to enter the program into the CMOS RAM memory of another TRANS-01 control; or can be stored for program backup. An EPROM can be erased off-line with an ultraviolet light, then can be reprogrammed and reused.

1.1.3 Keyboard/Display Panel

The standard control is equipped with a keyboard for programming, start-up and service, and with an alphanumeric display for display of current program data, axis position data, system status, diagnostics and program information.

Using simple English commands, the TRANS-01 user program is entered via the keyboard directly into the CMOS RAM memory of the control. Program changes and editing of program data are accomplished in the same manner directly at the control panel.

1.1.4 Diagnostic Monitoring

The TRANS-01 control continuously monitors all important functions of the system for correct operation. This includes all inputs, outputs, operating voltages, axis components, servomotor, tachometer, incremental encoder, limit switches, parameters and the user program.

When operating faults or disturbances are detected, the control switches to the Diagnostic Mode, shuts the system down, and issues a simple English language diagnostic message on the control panel display. This aids in the quick determination and correction of faults.

A special advantage is that the control records causes of intermittent problems which may already have disappeared again, and also diagnoses and identifies faults which trigger sequential events, such as loss of main power. This aids in quick correction of faults by plant personnel, rather than specialized electronic technicians.

With the addition of the Line Control Adaptor and TRXX version 6.X and above, the customer has the option of choosing his own extended diagnostics. The user can select up to 9 additional messages, in addition to the standard TRANS diagnostics. This enables the user to pinpoint problems and suggest remedies that are unique to the machine itself. For example:

1. Ackn Inp 7 wait 'on' <- Normal Status Diagnostic
2. Check wire # 32 for output
3. Check wire # 40 for signal

The diagnostic status of the control can be interrogated at any time, even when no error is present, by selecting Diagnostic Display Mode. Thus, normal status indications, such as "NO START", can be observed; and causes of interruptions which do not appear as errors, such as the control waiting for an auxiliary function acknowledgment, can be determined. In on-line operation, the fault can be detected by the master control via the data bus.

1.1.5 Adaptability of the Control

The TRANS-01 is integrated to the machine and the drive by entering various parameters when the system is initialized, e.g., maximum feedrate, accel/decel rate, incremental encoder cycles per revolution, etc.

This feature allows drive conditions and positioning resolution characteristics for a number of different machines to be adapted to a single type of control, with the control then producing correct position gain. Thus, standard programming procedures are maintained regardless of machine structure.

With this system, ballscrew pitch and gear ratios can be chosen based solely on thrust needs and desired rapid traverse rates. Thus, feed drives and position encoders can be standardized. This concept permits standard components to easily be adapted to differing machine requirements, reduces requirements for spares, and allows quick and easy replacement of controls by plant electricians if service is necessary.

SPINDLE DRIVE CONTROL

With TRANS-01 controls containing TRxx-004.0 or later Executive Software, in addition to the standard axis, a spindle drive may be controlled via the TRANS. Spindle speeds can be entered in any block in a user program, directly in spindle drive train output speed (e.g., tool RPM). Velocity commands are performed using a standard 0-10V analog command signal. As with the axis drive, monitoring of the spindle motor and it's controller is automatically performed by the TRANS and appropriate diagnostic or fault messages are displayed. The TRANS intelligently monitors the spindle's speed, allowing it to accelerate during a rapid traverse motion, but insuring it remains within tolerance of programmed speed during other program functions. Provisions are made to allow returning the slide in the event of a spindle overload or malfunction, and to allow operation of the slide without the spindle operational (useful in set up or tool change conditions).

Beginning with TRxx-005.0, TRANS Executive Software also includes the ability to command spindle positions (orient the spindle) by closing a position loop around the spindle motor and an incremental encoder. Any position between 0.0 degrees and 359.9 degrees (at the spindle drive train output, e.g., tool) may be programmed. Programming resolution is 0.1 degrees. A spindle position can be programmed in any block within the user program. As the spindle encoder is mounted directly on the spindle drive train, positions are programmed directly in spindle drive train output units (e.g., tool position). Spindle orientation can be performed when a transmission is present between the motor and output.

NOTE: Spindle positioning may not be used in conjunction with the Adaptive Depth Control Option (Executive Software TRx5-xxx.x) nor with the Adaptive Feed Option (TRx4-xxx.x).

JUMP ON EVENT

Certain applications require that the current running program be interrupted by an external signal or event and from that point continue in a different manner. Beginning with TRxx-005.0, TRANS Executive Software will include this option.

1.1.6 Options

A number of options are available with the TRANS-01, including EPROMS for permanent storage of programs and parameters, an EPROM programmer and interface for 115 Vac signals. By installing the appropriate optional software, adaptive depth control, feed adaption, rotary motion control or feed ramp capabilities are provided. In addition, the TRANS can be set to provide external tool correction, linear scale feedback, and an analog output for spindle control.

Options, including interfacing and programming, are discussed in Chapter 9.

1.2 OPERATING MODES

The TRANS-01 is a complete NC control and can be operated off-line or can be tied to a Line Control system over a data bus. This permits the TRANS to be employed for completely self-contained tasks.

When complete processing lines are put into initial operation, this off-line capability allows initial operation and testing of each distributed processing TRANS-01 unit, even before the Line Control installation has been completed.

The following modes of operation are provided by the TRANS-01 for execution of its control functions:

Automatic Operation -- Remote operation via the Cycle Interface signals supplied from the customer's Line Control device.

Functions Include:
- Programmed motions
- Single cycle
- Emergency home

Operator Interface -- Operation using pushbuttons mounted on an operator control panel external to the TRANS-01.

Functions Include:
- Programmed forward motion (via pushbutton)
- Programmed reverse motion (via pushbutton)
- Move to toolchange position

Set-up Operation -- Operation using the keyboard of the TRANS-01.

Functions Include:
- Homing
- Continuous operation
- Single block operation
- Single cycle operation
- Jogging forward and reverse

1.3 DISPLAY MODES

The TRANS-01 control provides the following display modes for programming, program testing, checking system status and operator and service support:

1. Block display for:
   - Programming
   - Program review
   - Display of the current block during program execution

2. Display of actual position, actual feedrate and actual auxiliary function status.

3. Display of commanded position (destination), programmed feedrate and programmed auxiliary function status.

4. Display of following error (deviation), feedrate override and existing discrepancies between commanded auxiliary functions and their respective expected acknowledgments.

5. Display of current programmed feedrate, feedrate override, BCD output, currently selected tool correction register number, and current reverse vector block number.

6. Status and fault diagnostics.

7. Tool correction display mode.

1.4 ENGLISH LANGUAGE PROGRAMMING

The basic program for standard motions is preprogrammed. The user simply prepares a program of up to 128 motion control blocks, each consisting of up to 9 operating commands such as type and length of axis movement, feedrate, homing, BCD outputs, dwells and auxiliary operations. Jump programming (including a jump based on external inputs) and repetition of one or a number of commands is easily selected for programming cyclic operations.

Tool position corrections can be programmed to allow operator compensation for tool wear.

When using numeric controls, programming a control requires the memorizing of many NC codes and symbols that are recognizable by the control, but not particularly meaningful to the operator. This problem is eliminated in the TRANS-01, by using simple English language dialog programming. The TRANS-01 "talks" with the programmer, requesting him to select a function, then prompting him through the entry of the information required to perform that function, using simple English prompts in the operator panel display.

1.5 OPERATOR KEYBOARD/DISPLAY PANEL

The TRANS-01 is simple and easy to program. The operator keyboard/display panel contains all controls and indicators necessary to program and operate the control. The program keys are identified with ISO symbols which indicate their function.

The keyboard/display panel is used:

1. To enter parameters such as maximum feedrate, rapid traverse rate, etc., which are used to adapt the control to the characteristics of a particular machine.

2. To enter a control program to perform the required machine functions.

3. To enter tool correction values.

4. For operation of the control in Single Cycle, Single Block and Hand Modes.

5. For display of diagnostic codes which indicate the nature of any problems detected in the machine, control, motor and feedback loop.

1.6 USER ACCESS LEVELS

Access to the TRANS-01 functions is, for practical needs, divided into 5 levels. They are interlocked to provide the widest possible margin of safety to prevent misuse of the control. These access levels are:

1. Engineering Interface

   At this level, the TRANS-01 control is adapted to the drive and machine via direct input of parameters using the TRANS-01 keyboard/display panel. Because the entry of incorrect data can result in damage to the machine, access at this level is possible only by unlocking the TRANS-01 cover and using the Parameter Keyswitch to enable Parameter Entry/Edit Mode. Parameter entry is described in Chapter 4.

2. Programmer Interface

   At this level, the control program is entered, and possibly edited, in Dialog Mode. This program must be protected from accidental or intentional alteration by unauthorized personnel. Thus, access to the user program can be made only by unlocking the TRANS-01 cover and utilizing the Programming Keyswitch to enable Programming Entry/Edit Mode. Programming is described in Chapter 5.

3. Toolsetter Interface

   Because special knowledge is needed for the toolsetter level, the TRANS-01 keyboard/display is accessible only by unlocking the panel cover. The toolsetter can then examine the program and parameters, operate the manual controls and enter tool correction values, as described in Chapter 3. He cannot change the program or parameters without using an additional keyswitch to separately enable each of those modes.

4. Operator Interface

Because it is necessary for an Operator to have access to Manual Mode controls in the course of normal operation, the TRANS-01 includes a parallel interface for a unit Operator Station. This station and its control buttons and switches, is provided by the machine builder. Normal programmed movements (including forward, reverse, homing and move to toolchange position), can be commanded from this station, assuming the necessary enables are provided by the TRANS-01. Operator functions are described in Chapter 3.

5. Cycle Interface

For operation of the TRANS-01 by the customer's Line Control, it is equipped with a parallel cycle interface over which operating commands can be transmitted. In Automatic Mode, all controls of the TRANS-01 occurs either via this interface or the optional Line Control Adaptor. The Cycle Interface is described in Chapter 6.

1.7 SYSTEM ELEMENTS

The TRANS-01 Control System includes:

* The control computer with diagnostic system and monitor logic.
* An EPROM memory for the executive program and a RAM memory for user programs and data, protected against power failure by lithium battery backup.
* Numerical control interface for the axis with input circuitry for the incremental position encoder, travel limit switches and homing switch.
* Input/output bus interface for the Line Control.
* Signal interface for an Operator Station panel.
* Control and monitoring for up to 8 auxiliary functions.

1.8 TECHNICAL DATA

Dimensions and Physical Specifications

TRANS-01 cabinet specifications	
Height	16.14 in (410 mm)
Width	12.60 in (320 mm)
Depth	6.2 in (155 mm) for plug-in connectors
Weight	30.0 lb (13.6 kg)
Power required	115/220 Vac ± 20%, 50/60 Hz
Power consumption	approximately 60 watts
Maximum ambient temperature	45 °C (113 °F)
Control interconnections	via sealed plug-in connectors
ScanTime is substantially less than 10ms per block	24V 10mA ±15V 60mA

Control Specifications

Number of axes controlled	one
Dimensioning system	inch or metric
Programming resolution	0.0001 inches; 0.001 mm
Maximum traverse distance	±838.8600 in; ±8388.600 mm
Feedrate	programmable
Rapid traverse rate	programmable
Maximum system speed	0.1 to 3276.7 in/min; 1.0 to 32767 mm/min
Maximum rapid traverse rate	19,600 in/min; 196000 mm/min
Jogging	forward/reverse
Number of program blocks	up to 128
Repetition cycles/block	up to 99
Programmed tool position corr.	up to 20
Dwell time	programmable from 0.01 to 99.99 sec
Aux functions	individually programmable on/off up to 8
Adjustable machine parameters	include encoder pulses/motor rev., maximum feedrate, jog speed, inch/metric units, auto home direction reversal, zero reference position, rapid traverse rate, jogging speed, motor direction reversal, etc.
Subroutine nesting	up to 16 deep
Self diagnostic conditions	detection of over 75 possible malfunctions including: encoder fault, invalid system parameter, motor overtemperature, limit switch activated, servo voltage error, normal stop, enable signal missing, auxiliary function acknowledgment missing, memory overflow, etc.

Interface Requirements

Input signals	+24 Vdc, Imin = 0.01 A, isolated from internal control circuitry.
Output signals	+24 Vdc, Imax = 50 mA (Cycle Interface and BCD outputs)/150 mA (auxiliary outputs) per output, short circuit protected, isolated from internal control circuitry.

Interfaces (described in detail in Chapter 6)

Parallel cycle interface	used to exchange control, interlock and status information with a Line Control.
Parallel operator interface	used for control signals to/from a local Operator Station.
Servo interface	provides control of a servo drive with incremental position feedback and inputs for home and overtravel limit switches.
Auxiliary functions/ acknowledgments	used for direct control and acknowledgment of program dependent switching functions.
RS422 serial interface	used for high speed communication with Indramat's Line Control Adaptor (LCA). Functions include: program or parameter downloading or uploading, status and diagnostics reporting and line operation.